RESEARCH DEPARTMENT

A method of calibration of an experimental vertical aperture corrector

REPORT No. T-097/2

1963/16

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

A METHOD OF CALIBRATION OF AN EXPERIMENTAL VERTICAL APERTURE CORRECTOR

Report No. T-097/2

(1963/16)

D. Maurice

D. Howorth, B.Sc. Tech.

(D. Maurice)

Report No. T-097/2

A METHOD OF CALIBRATION OF AN EXPERIMENTAL VERTICAL APERTURE CORRECTOR

Report No. T-097/2

April 1963

(1963/16)

A METHOD OF CALIBRATION OF AN EXPERIMENTAL VERTICAL APERTURE CORRECTOR

SUMMARY

This report describes a simple and convenient pulse method of calibrating the experimental vertical aperture corrector described in Research Department Report No. T-097 (1962/32). The calibration is obtained in the form of a factor from which the steady-state amplitude/frequency characteristics and the effect of the aperture corrector on signal-to-noise ratio can be determined.

1. INTRODUCTION

One method of calibrating the vertical aperture corrector would consist of measuring steady-state amplitude/frequency characteristics but this would be tedious, especially as it would involve blanking the variable-frequency test wave in order to simulate a television signal. The pulse method to be described can be carried out rapidly, uses standard equipment, and yields information from which the amplitude/frequency characteristics and the effect of the aperture corrector on signal-to-noise ratio can be calculated.

2. METHOD OF CALIBRATION

A standard "2T" pulse is fed into the vertical aperture corrector and the delay lines are adjusted until the resultant pulse at the output just splits into three separate components: one positive pulse and two equal-amplitude negative pulses will result (see Fig. 1). The magnitudes of these pulses are measured by means of an oscilloscope and the ratio of negative- to positive-pulse magnitude computed. From a knowledge of this ratio, which can be conveniently termed the "calibration factor", the steady-state amplitude/frequency characteristics and the effect of the unit on signal-to-noise ratio can be calculated.

2.1. Calculation of Amplitude/Frequency Characteristics

Let the calibration factor be denoted by ξ. It is apparent from Fig. 1 that the output of the vertical aperture corrector when adjusted for normal working conditions is given by the equation

$$g(t) = f(t - \tau) - \xi[f(t) + f(t - 2\tau)] \qquad (1)$$

where $f(t)$ and $g(t)$ are the input and output signals respectively and τ is the duration of one television line.

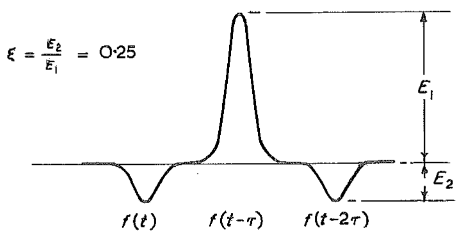

Fig. 1 - Output of the vertical aperture corrector

In order to obtain the steady-state amplitude/frequency characteristics of the aperture corrector let

$$f(t) = \cos \omega t$$

Hence

$$g(t) = \cos \omega(t - T) - \xi[\cos \omega t + \cos \omega(t - 2T)]$$

This expression simplifies to

$$g(t) = [1 - 2\xi \cos \omega T] \cos \omega(t - T) \qquad (2)$$

from the modulus or amplitude of which the amplitude/frequency characteristics can be calculated for various values of ξ.

In a practical vertical aperture corrector it is preferable to design the circuits so that adjustment of the amount of equalization does not change the magnitude of the output signal corresponding to a plain area of uniform grey. In this case the output of the vertical aperture corrector can be represented by the equation

$$g'(t) = f(t - T) + \nu[2f(t - T) - \{f(t) + f(t - 2T)\}]$$

where ν is a constant depending upon the amount of equalization. The term in square brackets, which represents the correction signal, reduces to zero for a "d.c. signal" corresponding to uniform grey.

Simplifying this equation gives

$$g'(t) = \left\{f(t - T) - \frac{\nu}{1 + 2\nu}\left[f(t) + f(t - 2T)\right]\right\}(1 + 2\nu) \qquad (3)$$

By comparing equations (1) and (3) we see that

$$\xi = \frac{\nu}{1 + 2\nu} \qquad (4)$$

Equation (4) shows that with this arrangement, the calibration factor ξ cannot exceed 0·5 and thus the corrected picture as a whole cannot change polarity.

In the experimental vertical aperture corrector the maximum value of ξ which is available is 0·25; this is found to be more than adequate for most purposes. Amplitude/frequency characteristics of the vertical aperture corrector for various values of ξ and a line duration of 100 μs are given in Fig. 2; this diagram may be adjusted to suit any television standard by a linear transformation of the scale of the frequency axis.

2.2. Calculation of the Effect on Signal-to-Noise Ratio

Let the magnitude of the input signal corresponding to white be E_1 volts and the r.m.s. voltage of the noise associated with it be e_1. The signal-to-noise ratio of the input signal may be defined as

$$N_1 = 20 \log_{10} \frac{E_1}{e_1}$$

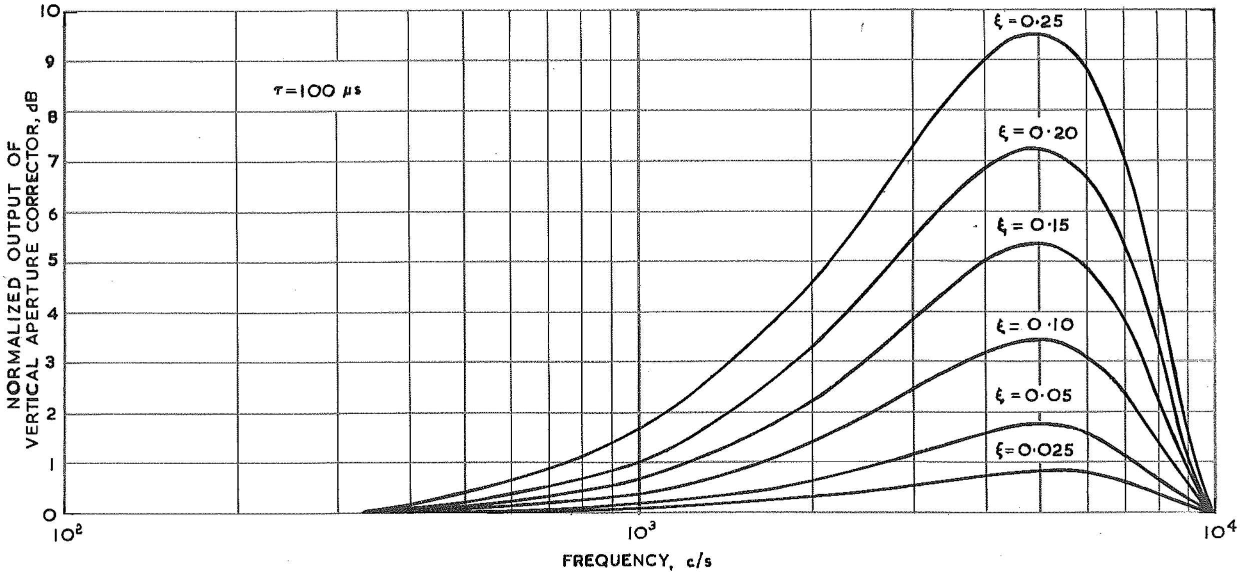

Fig. 2 - Amplitude/frequency characteristics of the vertical aperture corrector for the British 405-line television system

Consider the effect of the vertical aperture corrector on the signal alone. The output voltage E_0 corresponding to white will be given by equation (1) in Section 2.1. Hence, remembering that a delay $n\tau$ has no effect upon a d.c. signal representing large areas of uniform grey level,

$$E_0 = E_1 \quad [1 - 2\xi]$$

The calculation of the effect of the vertical aperture corrector on noise is more complicated but it may be considerably simplified, without introducing an appreciable objective error, if only the noise components above about ten times the television line-scanning frequency are considered.* In this case the noise components of the three signals, which together form the output signal, will be virtually uncorrelated owing to the relatively long delay between them. The output noise voltage may therefore be calculated from the addition of the three noise powers.

$$\text{Hence } e_0 = e_1 \quad [1 + 2\xi^2]^{\frac{1}{2}}$$

* Noise components below about ten times the television line-scanning frequency will appear mainly as fluctuation in brightness from line to line, which will give the picture a striated appearance. As the r.m.s. magnitude of these striations is proportional to the square root of their bandwidth, they will be at least 20 dB below the r.m.s. magnitude of the full video bandwidth noise. Hence the "subjective error" introduced by this simplification will also be small. In practice the action of circuits which are intended to restore the "d.c. component" of the video signal from line to line will help to minimize the visibility of the striations.

where e_0 is the r.m.s. voltage of the output noise. The output signal-to-noise ratio is given by

$$N_0 = 20 \log_{10} \frac{E_0}{e_0}$$

$$= 20 \log_{10} \frac{E_1 \; (1 - 2\xi)}{e_1 \; (1 + 2\xi^2)^{\frac{1}{2}}}$$

$$\text{or} \quad N_0 = N_1 + 20 \log_{10} \frac{(1 - 2\xi)}{(1 + 2\xi^2)^{\frac{1}{2}}}$$

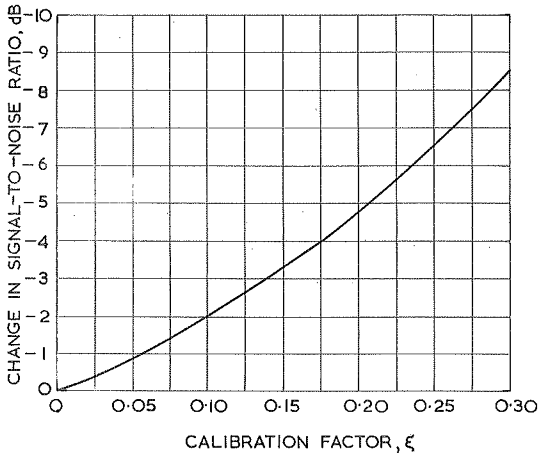

Fig. 3 - Change in signal-to-noise ratio as a function of the calibration factor

As the calibration factor must lie between 0 and +0·5, the final term in this expression must be negative and represents the decrease in signal-to-noise ratio caused by this form of vertical aperture correction. Fig. 3 shows calculated values of the change in signal-to-noise ratio plotted against the calibration factor ξ.

3. CONCLUSION

The method of calibration described has been found to be very satisfactory in practice. If an operational vertical aperture corrector were designed provision could be made for a series of pulses to be added to the incoming signal during the field blanking period in order to be able to check the performance of the equipment continuously.

ALG

Printed by B.B.C. Research Department, Kingswood Warren, Tadworth, Surrey